

REMARKS

This is a full and timely response to the non-final Office Action (Paper No. 6) mailed by the U.S. Patent and Trademark Office on September 11, 2002. Upon entry of this Response with Amendments, claims 19, 24-26, and 36-41 stand pending in the present application. Independent claim 19 has been amended to comply with 35 U.S.C. §112, Second Paragraph, and to further define the present invention. Claims 36-41 have been added to claim additional embodiments of the present invention. In addition, Applicants have amended the Specification to correct informalities. It is believed that no new matter has been introduced by way of these amendments. In view of the foregoing amendments and following remarks, reconsideration and allowance of the present application and claims are respectfully requested.

Amendments to the Specification

The Office Action rejected to the disclosure for having informalities. Specifically, pages 1, 4, 9, 13, and 19 were objected to for not containing the patent number of the issued US Patents. Applicants have amended the specification to correct the informalities.

In addition, the abstract of the disclosure was objected to for describing a method rather than an apparatus. Applicants have amended the abstract to more closely reflect the claimed apparatus.

Rejections under 35 U.S.C. §112, Second Paragraph

Claim 19 and 24-36 stand rejected under 35 U.S.C. §112, Second Paragraph, as being indefinite for failing to particular point out and distinctly claim the subject matter, which Applicants regards as the invention. Applicants have amended claim 19 so that it is clear that the mechanical support is “isolated from the plasma creation means.” Accordingly, Applicants respectfully submit

that claim 19 is in compliance with 35 U.S.C. § 112, Second Paragraph, and respectfully request that the rejection be withdrawn.

Rejections under 35 U.S.C. §102

Claims 19 and 24-26 stand rejected under 35 U.S.C. §102(b) as being anticipated by Kaji et al. (US Patent No. 5,290,993); Gorin (US Patent No. 4,464,223); and Okano et al. (JP 56-81678-A). A proper rejection of a claim under 35 U.S.C. §102 requires that a single prior art reference disclose each element of the claim. See, e.g., W.L. Gore & Assoc., Inc. v. Garlock, Inc., 721 F.2d 1540, 220 USPQ 303, 313 (Fed. Cir. 1983). Anticipation requires that each and every element of the claimed invention be disclosed in a single prior art reference. See e.g., In re: Paulsen, 30 F.3d 1475, 31 USPQ 2d 1671 (Fed. Cir. 1994); In re Spada, 911 F.2d 705, 15 USPQ 2d 1655 (Fed. Cir. 1990). Alternatively, anticipation requires that each and every element of the claimed invention be embodied in a single prior art device or practice. See, e.g., Minnesota Min. & Mfg. Co. v. Johnson & Johnson Orthopedics, Inc., 976 F.2d 1559, 24 USPQ 2d 1321 (Fed. Cir. 1992). For anticipation, there must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention. See, e.g., Scripps Clinic & Res. Found. v. Genentech, Inc., 927 F.2d 1565, 18 USPQ 2d 1001 (Fed. Cir. 1991.)

Accordingly, the single prior art reference must properly disclose, teach or suggest each element of the claimed invention.

It is alleged in the Office Action that:

Kaji et al teach an apparatus (Fig.1) for plasma etching a sample 14, the apparatus comprising:

a bell jar 3 and a vessel 4 defining a plasma generating and plasma processing space (*plasma reactor*), wherein the plasma is generated by a microwave generator 1; and

a sample table 10 (*mechanical support within the plasma reactor*), wherein the sample table 10 is coupled to an AC power source 16 and a DC power source 18 for applying a bias voltage on the sample table 10 (*the support is electrically connected to both a dc and an ac bias source*) (column 2, line 41 through column 3, line 41).

With regards to *Kaji et al.*, Applicants submit that *Kaji et al.* fails to disclose each feature of the claimed invention. Specifically in claim 19, Applicants have claimed a mechanical support that is electrically biased and “responsive to electrically biasing said substrate to a first electrical potential, the substrate is electrically **neutralized** by positive ions of the plasma, and whereby responsive to electrically biasing said substrate to a second electrical potential, the substrate is **etched** by electrons of the plasma.” Applicants respectfully submit that *Kaji et al.* apparently fails to disclose biasing the substrate such that it is etched by electrons or neutralized by positive ions. Rather, *Kaji et al.* discloses etching the substrate using ions. (See column 4, lines 8-13.) Therefore, Applicants respectfully request that the rejection of claim 19 based upon *Kaji et al.* be withdrawn.

It is further alleged in the Office Action that:

Gorin teaches an apparatus (Fig.2) for plasma etching a workpiece, the apparatus comprising:

a reactor defining a reaction volume 20 (*plasma reactor*), wherein the plasma is generated by a high frequency power source 30 coupled to a plasma generating electrode 12; and

a workpiece support electrode 14 (*mechanical support within the plasma reactor*), wherein the workpiece support electrode 12 is coupled to an AC power supply 36 and a DC power supply 42 for applying a bias voltage on the workpiece support electrode 12 (*the support is electrically connected to both a dc and an ac bias source*) (column 2, line 7 through column 3, line 17).

With regards to *Gorin*, Applicants have claimed in claim 19 the feature of “said mechanical support isolated from the plasma creation means.” According to the Office Action, *Gorin* discloses “ a workpiece support electrode 14 (*mechanical support within the plasma*

reactor), wherein the workpiece support electrode 12 is coupled to an AC power supply 36 and a DC power supply 42 for applying a bias voltage on the workpiece support electrode 12 (*the support is electrically connected to both a DC and a AC bias source*) (column 2, line 7 through column 3, line 17).” However, Applicants respectfully submit that *Gorin* appears to disclose that the power supply 36 creates a plasma within the reaction volume. (See column 3, line 31-33). Thus, Applicants respectfully submit that *Gorin* fails to disclose a mechanical support isolated from a plasma creation means, as claimed by Applicants in claim 19. Accordingly, Applicants respectfully request that the rejection of claim 19 based upon the above references be withdrawn.

In addition, *Gorin* apparently fails to disclose a mechanical support within the plasma reactor as claimed by Applicants. Applicants respectfully submit that *Gorin*’s lower electrode 14, which is the workpiece holder, is part of the containment vessel for the plasma reactor. Specifically, it is adapted for vertical movement allowing it to be lowered so that a substrate can be placed thereon and then raised “to the closed position.” (See column 2, lines 51-57.) Applicants respectfully submit that the electrode 14 is not within the plasma reactor as claimed by Applicants. Therefore, Applicants respectfully submit that the rejection based upon this reference is improper because it fails to disclose the claimed element and respectfully request that the rejection be withdrawn.

It is further alleged in the Office Action that:

Okano et al teach an apparatus (Fig. 5) for plasma etching a material, the apparatus comprising:

a *plasma reactor* 36, wherein the plasma is generated by a high frequency power source 31 coupled to discharge electrodes 28, 29; and

an electrode 25 supporting a material 26 to be etched (*mechanical support within the plasma reactor*), wherein the material support electrode 25 is coupled to an AC power supply 33 and a DC power supply 35 for applying a superimposed bias current on the material support electrode 25 (*the support is electrically connected to both a dc and an ac*

bias source) (abstract describing Fig. 3 having components similar to those shown in Fig. 5).

With regards to *Okano et al.*, Applicants respectfully request that the USPTO either provide further explanation of the reference or an English translation of the reference or withdraw the reference. Under 37 CFR §1.104(c)(2), “[t]he pertinence of each reference, if not apparent, must be clearly explained in each rejected claim specified.” In light of the English translation of the abstract, Applicants respectfully submit that there is no indication of a mechanical support that is electrically biased such that ““responsive to electrically biasing said substrate to a first electrical potential, the substrate is electrically **neutralized** by positive ions of the plasma, and whereby responsive to electrically biasing said substrate to a second electrical potential, the substrate is **etched** by electrons of the plasma,” as claimed by Applicants in claim 19. Therefore, Applicants do not believe that the reference anticipates the claimed invention.

Response to Cited Art of Record That Was Not Relied Upon

The Office Action alleges that Tamura *et al.* (US Patent No. 5,906,684), which was not relied upon in the Office Action, discloses “a plasma reactor including a substrate holding system coupled both to DC power source 13 and AC power source 12 (Fig. 10).” Applicants have claimed in claim 19 the feature of “said mechanical support isolated from the plasma creation means.” Applicants respectfully submit that *Tamura et al.* appears to disclose a substrate holding system 9 coupled to an AC power supply 12 (see Fig. 1) and “[w]hen the high frequency power supply 12 is switched into operation or the microwave is introduced, a plasma 16 is produced in the etching chamber 10.” (See column 9, line 11-16.) Thus, Applicants respectfully submit that *Tamura et al.* fails to disclose a mechanical support isolated

from a plasma creation means, as claimed by Applicants in claim 19. Accordingly, Applicants do not believe that the cited reference discloses Applicants' claimed invention.

Newly Added Claims

Applicants have added independent claim 36 and claims 37- 42, which are dependent from claim 36. Applicants regard claim 36 as being patentable over the cited art of record for at least the following reasons. In claim 36, Applicants have claimed the feature of a mechanical support that is electrically biased such that "biasing said substrate to said second electrical potential attracts positive ions from said plasma to said substrate for **electrically neutralizing said substrate** and biasing said substrate to said third electrical potential attracts ions from said plasma to said substrate for **etching said substrate**." Applicants respectfully submit that the cited art of record fails to disclose each feature of the claimed invention. Therefore, Applicants respectfully submit that the claimed invention is allowable. Furthermore, Applicants respectfully submit that dependent claims 37-42 are allowable for at least the reason that they depend either directly or indirectly from allowable independent claims. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988.)

Double Patenting

Claims 19 and 24-26 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 29-32 of U.S. Patent No. 6,033,587.

According to the Office Action:

Claims 19 and 23-26 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 29-32 of U.S. Patent No. 6,033,587. Although the conflicting claims are not identical, they are not patentably distinct from each other because in claims in the present application are essentially similar to claims in the US Patent No. 6,033,587.

Claims 19 and 23-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Martin et al (US Patent No. 6,033,587).

Martin et al teach an apparatus (Fig. 1) for low-damage anisotropic dry etching of a substrate, the apparatus comprising:

A plasma reactor; and

A mechanical support within the plasma reactor, wherein the mechanical support is coupled to an AC electrical bias or a DC electrical bias or both (column 9, line 55 through column 10, line 52, and claims 24-32)

Applicants have filed herewith a terminal disclaimer, disclaiming the term of any patent to issue on the instant application to the term of U.S. Patent No. 6,033,587 to *Martin, et al.*

Accordingly, Applicants respectfully submit that the obviousness type double patenting rejection has been obviated and request that the rejection be withdrawn.

CONCLUSION

For at least the foregoing reasons, Applicants respectfully request that all outstanding rejections be withdrawn and that all pending claims of this application be allowed to issue. If the Examiner has any comments regarding Applicants' response or intends to dispose of this matter in a manner other than a notice of allowance, Applicants request that the Examiner telephone Applicants' undersigned attorney.

Respectfully submitted,

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ANNOTATED VERSION OF MODIFIED SPECIFICATION TO SHOW CHANGES
MADE

The following is a marked up version of the amended specification wherein brackets [] denote deletions and underlined text denote additions.

In the paragraph that spans page 1, lines 7-16 please amend the paragraph by inserting the underlined text:

This application is a division of U.S. Application Serial No. 08/932,025, now U.S. Pat. No. 6,258,287, entitled 'Method And Apparatus For Low Energy Electron Enhanced Etching of Substrates in an AC or DC Plasma Environment, filed September 17, 1997, which claims priority to and the benefit of the filing date of Provisional Patent Application Serial No's. 60/026,985, filed September 20, 1996, entitled "APPARATUS AND PROCESS FOR LOW-DAMAGE DRY ETCHING OF INSULATORS BY LOW ENERGY ELECTRON ENHANCED ETCHING IN A DC PLASMA"; 60/026,587, filed September 20, 1996, entitled "APPARATUS AND PROCESS FOR LOW-DAMAGE DRY ETCHING OF INSULATORS BY LOW ENERGY ELECTRON ENHANCED ETCHING IN AN AC PLASMA"; and U.S. Patent Application Serial No. 08/705,902, now U.S. Patent No. 5,882,538, filed on August 28, 1996 entitled "METHOD AND APPARATUS FOR LOW ENERGY ELECTRON ENHANCED ETCHING OF SUBSTRATES".

In the paragraph that spans page 4, lines 19-28, and page 5, lines 1-5 please amend the paragraph by inserting the underlined text and deleting the bracketed text:

Placing the sample to be etched on the anode within a DC plasma environment is one way to ensure precise control over the anisotropic etching process while minimizing damage to the substrate and is described in commonly assigned [copending U.S. Patent Application Serial No. 08/705,902] U.S. Patent No. 5,882,538, filed August 28, 1996 and entitled "METHOD AND APPARATUS FOR LOW ENERGY ELECTRON ENHANCED ETCHING OF SUBSTRATES". This technique is called *Low Energy Electron Enhanced Etching* (LE4, for convenience), and operates by placing the etching substrate on the anode of a DC glow discharge. This method works well for conducting and semi-conducting substrates, but is inherently problematic for etching non-conducting substrates such as insulators because, in the aforementioned method, the substrate sample is physically and electrically connected to the anode in the plasma, thus becoming a conducting element of the electrical circuit within the plasma. An insulator, by definition does not efficiently conduct electrical current; therefore, placing an insulating substrate on the anode will impede the electrical flow and will be an inefficient and nearly impossible way to etch a non-conducting substrate.

In the paragraph that spans page 9, lines 19-26 please amend the paragraph by inserting the underlined text and deleting the bracketed text:

In a variation of this third embodiment, for etching conducting substrates, the sample is placed upon the anode of a dc plasma reactor as described in commonly assigned [copending U.S. Patent Application Serial No. 08-705,902] U.S. Patent No. 5,882,538, filed August 28, 1996 and entitled "METHOD AND APPARATUS FOR LOW ENERGY ELECTRON ENHANCED

ETCHING OF SUBSTRATES”, however as an improvement thereon, the additional structure as described above is placed within the plasma in close proximity to the sample, thus allowing improved precise control over the flux and energy of charged species being imparted to the sample.

In the paragraph that spans page 13, lines 10-22 please amend the paragraph by inserting the underlined text and deleting the bracketed text:

In all embodiments that use conductors to generate the low energy electrons desired to form the plasma flux, the cold cathode can be a hollow cathode formed with permeable, meshed, or perforated, generally referred to as permeable, walls rather than the typical solid walls. The cathode may be cylindrically shaped with a side wall of a permeable conductive material, such as stainless steel mesh, and having one end that is open or closed and an open end. The cathode is connected to a cathode mounting post and to the power supply. The cathode may comprise a plurality of nested sidewalls; each connected to the power supply. The use of this cathode allows the generation of a large flux of low energy electrons at low pressure and temperature. A cathode made in accordance with that described is described in [copending] commonly assigned U.S. Patent No. 5,917,285 [Application Serial No. XXX], filed July 23, 1997, entitled “APPARATUS AND METHOD FOR REDUCING OPERATING VOLTAGE IN GAS DISCHARGE DEVICES”.

In the paragraph that spans page 19, lines 4-13 please amend the paragraph by inserting the underlined text and deleting the bracketed text:

Cathode 56 is mounted in the plasma chamber 11. Cathode 56 is preferably a cold cathode, sometimes referred to as a field emission cathode, meaning it functions without the application of heat. The cathode is activated using external power source 54 that applies a direct current (DC) voltage between cathode 56 and anode 51. Because the chamber contains a gas, the chamber functions as a DC glow-discharge tube or DC plasma reactor. The cathode may be a standard cold cathode such as are known in the art or one constructed in accordance with the teaching of [copending] commonly assigned U.S. Patent No. 5,917,285 [Application Serial No. XXX], filed July 23, 1997, entitled "APPARATUS AND METHOD FOR REDUCING OPERATING VOLTAGE IN GAS DISCHARGE DEVICES".

In the paragraph that spans page 26, lines 2-8 please amend the paragraph by inserting the underlined text and deleting the bracketed text:

An apparatus for [method of] low-damage, anisotropic etching of substrates [including mounting] having the substrate mounted upon a mechanical support located within an ac or dc plasma reactor. The mechanical support is independent of the plasma reactor generating apparatus and capable of being electrically biased. The substrate is subjected to a plasma of low-energy electrons and a species reactive with the substrate. An additional structure capable of being electrically biased can be placed within the plasma to control further the extraction or retardation of particles from the plasma.

ANNOTATED VERSION OF MODIFIED CLAIMS TO SHOW CHANGES MADE

The following is a marked up version of the amended claims. Amend the following claims by adding the language that is underlined (“___”) and by deleting the language that is enclosed within brackets (“[]”):

1 19. (Twice Amended) An apparatus for low-damage anisotropic dry etching of a substrate,
2 comprising:
3 a plasma reactor having a plasma creation means and adapted to have a plasma therein; and
4 a mechanical support within said plasma reactor, said mechanical support isolated from the
5 [creation of the] plasma creation means, wherein said mechanical support is electrically biased, said
6 mechanical support imparting said electrical bias upon the substrate, responsive to electrically
7 biasing said substrate to a first electrical potential, the substrate is electrically neutralized by positive
8 ions of the plasma, and whereby responsive to electrically biasing said substrate to a second
9 electrical potential, the substrate is etched by electrons of the plasma.